

The art of applying environmental science at a small watershed scale: A case study, Tseycum Creek, British Columbia.

Abstract:

Senior government agencies often lack an effective presence at the scale of small watersheds and ENGOs, which have a strong influence on human behavior at the scale of small watersheds, often lack the data and scientific understanding necessary to be effective. Peninsula Streams Society and Environment Canada are developing and evaluating an approach in which ENGOs can develop and present predictive scenarios custom tailored to the local decision-making process using Environment Canada's data and science. In this case study at Tseycum Creek, British Columbia, data and model visualization is used to develop a shared understanding amongst stakeholders of the nature and dynamics of the water quality issues in an effort to build consensus toward solutions.

Key Words:

Hydrology, modeling, pathogens, decision support, ENGO

Introduction

A diagnosis of an environmental pathology in a watershed should lead to the development of a prescription of education, persuasion, legislation, enforcement, or litigation to solve the problem. However, environmental decision-making is virtually blind to the sensitivity of either the local economy or of the environment to any proposed treatment plan. A fundamental constraint on good environmental governance is the limit to our capacity to know what is happening, where it is happening, when it is happening, and why it is happening.

A variety of technologies allow us to monitor the environment for a wide range of variables of interest but we simply cannot observe everything, everywhere, all of the time. We tend to focus our monitoring efforts at the scale of receiving waters that integrate the combined effects from all upstream contributing watersheds. This strategy allows for affordable detection of environmental signals and any associated trends, transients or cycles in those signals; regardless of where those signals originate in the source contributing area. Monitoring of receiving waters is a useful screening tool to detect environmental pathologies however this information is generally insufficient to attribute cause to the observed effects. Specific causal mechanisms are needed in order to develop effective treatment plans to retard or reverse undesirable trends in water quality.

Our faith in technological solutions to environmental problems can obscure the fact that when people cause problems, people must be part of the solution. Whereas technology alone is not up to the task of providing the information we need to influence decisions in small watersheds, grassroots Environmental Non-Government Organizations (ENGOs) often form spontaneously in response to observable environmental degradation at the scale of small watersheds. The people motivated to form or join ENGOs are often ones who have memories of healthy ecosystem function and a desire to restore that functionality to their neighborhood streams. These people know, to some extent, what is happening, when it is happening, where it is happening, and who has the jurisdiction or authority to change what is happening. The vital piece of information they often lack is 'why' the 'who', 'what', 'when' and 'where' are all connected. Unfortunately, most ENGOs lack the resources required to attribute accountability to the undesirable effects they observe.

Advances in environmental modeling allow us to quantify the propagation of the effects of anthropogenic interventions in the atmosphere, hydrosphere, cryosphere, lithosphere and biosphere. It is acknowledged that models cannot faithfully reproduce all of the environmental transactions that may be relevant to any given problem. Even if a model is only able to describe the gross features of an environmental outcome, that caricature of reality is often sufficient to educate, inform, persuade or intrigue stakeholders who otherwise lack a focal point for the development of a shared understanding of the dynamics of the system of interest.

There are many opportunities to develop a healthy and vibrant co-existence of culture, economy and environment in the Georgia Basin and Puget Sound. We are not so entrenched in our development path that we are doomed to persistent environmental degradation. However, the future health of the basin is dependant on actions, taken or avoided, at the scale of small watersheds. The development of a shared understanding of the connection between these actions and the downstream consequences of those actions can help communities arrive at consensus on strategies that will lead to desired futures. The concept that we wish to test in this project is that environmental modeling tools and techniques can be made available to influence the many 'small' decisions that collectively define the health of our watersheds.

Conceptual framework

Predictive modeling is commonly used as a tool for anticipating consequences of large projects and to provide the guidance necessary to avoid unwanted effects of those projects. The assumption that a project must be well-funded in order to benefit from the prescience of environmental models is based on the notion of customized model development, in which teams of engineers and scientists are needed to acquire and process the data for needed for calibration, forcing and validation of the models. In order for modeling to be affordable for evaluating the consequences of the many 'small' decisions that accumulate into basin-wide effects, an alternate modeling approach is required.

A framework is proposed in which a suite of models are linked together in such a way as to be useful for addressing re-current issues. This framework of models can then be rapidly adapted and calibrated to 'new' landscapes for re-use, with minimal incremental cost. These models must be simple enough to be useful without extraordinary data availability; they must be complete enough to represent the dominant processes controlling the propagation of impacts throughout a watershed; and they must be credible enough to build consensus in a multi-objective management context.

The deployment of this modeling framework calls for a new form of working relationship between ENGOs and Environment Canada. Whereas the development of this framework is being funded by the Georgia Basin Action Plan (GBAP), there are not enough scientists available to participate in the extensive, iterative, process of model scenario development for every watershed in the Georgia Basin for which the modeling framework may be useful. It is proposed that the modeling tools (with sufficient scientific consultation to provide the initial, site-specific, calibration and validation) be provided to stewardship groups. The ENGOs would then have the use of these tools to develop locally meaningful scenarios that will lead to an improved understanding of the environmental sustainability of alternate land management choices.

Local stewardship groups have much strength that will contribute to the success of this schema. They have a depth of understanding of the history, geography, economy and politics relevant to the local environmental issues that a visiting scientist would require months of study to acquire. As advocates, they are unconstrained in their freedom to explore innovative solutions that may transcend the mandate or jurisdictional boundaries of any single government agency. They also have the ability to explain the models to the target audience in a vocabulary that is meaningful to that audience at times, and in venues, that maximize participation in the process.

The strategy for testing this concept is to:

1. develop a predictive modeling framework for use in a test watershed
2. work with an ENGO to develop locally meaningful scenarios for the purpose of informing and motivating decision-making in support of sustainable futures
3. evaluate the effectiveness of the modeling framework for influencing the decision-making process
4. evaluate the portability of the modeling framework by applying it to a different watershed, and quantifying the time and effort required to adapt and re-calibrate the models to a different landscape.

Tseycum Creek

Tseycum Creek was chosen as a test watershed because it has an active ENGO (Peninsula Streams Society), engaged landowners, and severely degraded functionality contributing to socio-economic impacts

for the Tseycum First Nation, which is prevented from harvesting shellfish as a result of the effluent from Tseycum Creek contaminating Patricia Bay. The issues in the Tseycum Creek watershed are not unique. The land-use includes agriculture (primarily dairy), hobby farms, residential and rural residential developments. The native soil have very poor water holding capacity, which combined with the low relief of the basin has resulted in extensive drainage enhancements (tiling and ditching) to support the existing land-use.

Current status of the project

A literature review to identify models that satisfy the project criteria (simple, inclusive of relevant processes, credible) has led to the testing and evaluation of the HBV model for hydrological routing, the RAISON expert system for pathogen source tracking, and the AGNPS model for non-point-source nutrient dynamics into the modeling framework. The data necessary to set up and calibrate these models has been prepared and they are being evaluated in the local context for relevance and credibility. An interface is being designed that is tailored to a consensus-based approach for scenario creation and for meaningful display of model output for intuitive communication of results and for difference analysis of alternate treatments.

Next Steps

The modeling framework will be evaluated by having Peninsula Streams Society host a series of workshops in which stakeholders will have to address the many and varied factors that contribute to the problems manifest in the watershed in order to set the parameters implicit in scenario development. This discussion will expose the range of perceptions about watershed function and causes of impairment. Where there are no hard data to substantiate accurate estimates of any given factor, the perceived range of estimates can be run through the models for sensitivity analysis. The results of the sensitivity analysis can lead to various conclusions. For example, it may be determined that the watershed is insensitive to the full range of estimates; hence the inaccuracy or disagreement in the estimation of that factor is unimportant. An alternate finding could be that the watershed is extremely sensitive to the range in proposed estimates, which should result in two conclusions: first, that better information about that specific factor will lead to better solutions, and secondly that this factor is one for which some sort of management is required at the watershed scale.

The users will be surveyed at the conclusion of these workshops to evaluate their perception of the utility of the process and their confidence that the process will lead to the eventual achievement of desired outcomes. A follow-up survey to be conducted in the following year will be used to evaluate the extent to which expectations created during the workshops were translated into action on the ground.

The ease of adaptation of the modeling framework to a different landscape will be tested by application to the Little Campbell watershed which shares many issues in common with Tseycum Creek. A cost model for model deployment will be prepared based on the Little Campbell application in which the incremental costs for data preparation, site-specific calibrations and training of stewardship groups in the use of the models will be compiled and analyzed. User satisfaction surveys will be conducted (similar to the surveys done for Tseycum Creek).

Conclusion

Initial discussions with stakeholders indicate a keen interest in the use of predictive tools and techniques for watershed stewardship. Preliminary results from model evaluations are encouraging and support the notion that a 'public-user' interface can be designed that will expose important elements of functionality for scenario design, with minimal training requirements, for use by watershed stewardship groups. The credibility of the model outcomes is dependent on the 'expert' site-specific calibration and validation of the models. The 'technical-user' interface being designed for model set up, calibration and validation is greatly improving the efficiency with which these models can be spun-up for use.

The practicality and utility of this approach remains to be proven. Deployment and monitoring of the efficacy, of these concepts planned for the next phase of the project will determine whether predictive modeling techniques can be made widely available for influencing the many 'small' decisions that will determine the fate of the basin.